BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B69 10106

SUBJECT: Comments on the AAP Experiments MO71 and MO73 - Case 630

DATE: October 31, 1969

FROM: L. D. Sortland

ABSTRACT

The medical experiments MO71 and MO73 represent the only investigation of the inflight biochemistry of the human body on AAP. As such, they form the core of the medical program. The dietary requirements of the experiments and food acceptance by the crew impose quite strigent specifications on the food logistics system but a strategy for accommodating both is outlined in this memo. This food planning scheme allows maximum freedom of menu choice for the crew, and at the same time assures that the nutritional intake fulfills the experiment protocol.

Collection, measurement and sampling of the urine voids are required for MO71 and MO73. The present proposed system imposes so much crew stress that it is unlikely that the necessary data and samples will be collected.

NASW-417

BELLCOMM, INC.
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SUBJECT: Comments on the AAP Experiments M071 and M073 - Case 630

DATE: October 31, 1969

FROM: L. D. Sortland

MEMORANDUM FOR FILE

INTRODUCTION

An informal meeting was held at NIH to review the End Item Specifications Document for the AAP Food System prior to the Preliminary Requirement Review (PRR) meeting to be held at MSC on September 25. The purpose of the meeting was to ensure that the nutritional requirements for Medical Experiment M071 were adequately fulfilled. The attendance list, Attachment 1, included the Principal Investigator, Dr. Whedon, members of his staff, several outside experts in metabolic physiology, NASA representatives from Space Medicine and Houston, the AAP systems integration contractor, Martin-Marietta, and Bellcomm.

A mineral balance study similar to M071 was conducted on the 14 day Gemini 7 mission. The scientific value of the Gemini 7 results was seriously compromised by the difficulty in obtaining adequate pre- and post-flight data on the crew, and by the poor urine samples obtained during flight. In spite of these drawbacks, there were strong indications that in the weightless environment, losses of calcium were occurring. As has been shown by bed rest studies, the nearest earth-bound analog to zero g, these losses occur over extended periods and will cause weakening of the skeleton. Furthermore, these studies have shown that some bones exhibit preferential susceptability to calcium loss, so that the probability of their fracturing during re-entry following prolonged exposure to zero g is considerably increased over the skeleton as a whole.

In addition to bone weakening, other effects attributable to weightlessness can occur such as kidney stones (calcium deposits in the kidney) and the decrease in hormone production as evidenced by markedly lower 17-OH cortisone found in the urine of the Gemini 7 crew. The reduction in hormone production may be quite critical since the endocrine system can gradually atrophy if not stimulated. The hormones form a major part of the biological controls of the human body, and they are intimately involved with ability of the body to withstand stress. During extended missions, therefore, the stress reserves of the crew can be reduced, i.e., the ability of the endocrine system to react to emergency conditions is impaired.

AAP MEDICAL PROGRAM

The medical program on AAP consists of two major parts, the first made up of (a) a determination (and prevention if possible) of the deconditioning of the cardiovascular system using the Lower Body Negative Pressure Device, and (b) an evaluation of the cost of performing work in zero g using the bicycle ergometer and metabolic rate measuring device. The second part is composed of the M070 series of experiments: mineral balance, bone densitometry, and analysis of body fluids. These latter experiments are the only ones which can reveal alterations to the body's biochemistry during the course of the mission, and they appear to be fairly critical to the qualification of man for extended missions. It was emphasized by Dr. Leo Lutwak that for the mineral balance studies to have validity, the food input to each crewman must be accurately known and maintained constant both in the constituents of interest (calcium, potasium, sodium, magnesium, chloride, protein) and in caloric value. Furthermore, total mass or urine and feces must be collected on a daily basis and sampled. Failure to accurately and consistently perform these sampling tasks would compromise the value of the experiment.

DIET

The medical requirement that the food intake for a crewman must not vary from day to day, if at all possible, poses several interesting problems with crew acceptance and compliance, and with storing in the Dry Workshop prepackaged food for a crew not yet designated. Food preference is a highly individual phenomenon and subject to change according to the physio-psychological state of the man. On previous manned missions, food swapping between crew members and re-arrangement of the feeding schedule (interchange of breakfast, lunch and dinner food items) have occurred and this seems to improve crew acceptance of the diet. Therefore, it is very desirable to have built into the food logistics system the capability of (1) satisfying the experimental requirements for crewmen of differing caloric needs, and, (2) flexibility of food item selection during any 24 hour period. One possible approach to fulfill both of these rather stringent goals is outlined below:

1. Divide all of the food items into a small number (4 or 5) of categories;

2. In each category, the food items would be identical in those constituents of interest.

3. In any 24 hour period, each crewman would choose his own menu and consume it at his discretion. The only restriction placed on him would be the number of items from each category which would be predetermined. He would have to consume all of the prescribed number of items of this "core" diet.

4. The core diet would contain the daily quantities of all constituents of interest except for the caloric requirements. The caloric value of the core diet would be less than the minimum required for maintenance of body weight. Approximately 1800 calories seems a reasonable figure. This low caloric content of the core diet should make its total consumption by the crewman not unreasonable a task to perform.

5. To adjust the caloric intake to a value required to maintain body weight, pure carbohydrate can be consumed. By using a sugar containing drink (perhaps Tang or some substitute) quite precise metering of the caloric intake can be made quite independent of the mineral intake in the core diet.

This strategy satisfies the crew's desire for flexibility and at the same time enables the food management contractor to design a food inventory system which is reasonably simple and at the same time fulfills the experimental requirements for individuals in the crew with differences in nutritional needs.

SAMPLING

The crux of experiments M071 and M073 rests squarely on the accurate collection, measurement and sampling of the urine and feces from each crewman for each and every day. This is a onerous task for any man to perform in controlled earth-based facilities let alone under the stressed conditions of space flight. It is unlikely that the crew will be able to complete the experimental protocol unless the operating procedures for the waste management system are simple and rapid to use, and esthetically acceptable.

With the experimental requirement for total return of all feces, collection of each defecation in a bag appears to be the logical solution. From past experience, defecations will occur at one to three day intervals so that the inconvenience of using a bag should not be too stressful on the crew. The proposed fecal system is much better than the Gemini bag in that a canister is used with an air flow to direct the bolus to the bottom of the bag. Man testing of the system is planned.

The urine system will be used a nominal five times per day and consumes the majority of time spent in using the waste management system. It is important, therefore, to relieve the man of most of the urine measurement and sampling operations. The present proposed AAP system does not satisfy this need and as a result, the number of crew operations is considerable. The resulting stress on the crew over the duration of the mission will be quite high and it is doubtful whether the experimental requirements will be fulfilled.

CONCLUSIONS

1. Careful design of the food logistics system is required if the scientific value of the M071 experiment on AAP is not to be compromised. A strategy to fulfill the experiment dietary protocol has been suggested.

2. The current AAP urine collection, measurement and sampling system requires too many crew operations and it is doubtful whether the experimental requirements can be fulfilled without some compromise in scientific rigor.

1011-LDS-lmc L. D. Sortland

Attachment 1

Attachment 1

Meeting on Space Flight Diet Technology, September 18, 1969

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